CLAIMS

What is claimed is:

1. A method of generating a subscriber line ringing signal for a subscriber line having first and second lines, comprising:

a) applying a time-varying supply level $W(t)$ to the first line while maintaining the second line at a pre-determined supply level for a duration T/2; and

b) applying $W(t)$ to the second line while maintaining the first line at the pre-determined supply level for the duration T/2, wherein a resulting ringing signal component of the first line is $L1(t)$, wherein a resulting ringing signal component of the second line is $L2(t)$, the first and second lines form a differential ringing signal line pair providing a differential ringing signal $\Delta L(t) = L1(t) - L2(t)$ having a period T.

2. The method of claim 1 wherein $W(t)$ is periodic with period T/2.

3. The method of claim 1 wherein $L2(t) = L1(t + T/2)$.

4. The method of claim 1 wherein $W(t)$ resembles one of a full-wave rectified sinusoidal and a full-wave rectified trapezoidal waveform.

5. The method of claim 1 wherein the differential ringing signal $\Delta L(t)$ is one of a sinusoidal, a trapezoidal, a sawtooth, and a triangular waveform.

6. The method of claim 1 further comprising:

d) repeating steps a) – b).

7. The method of claim 8 wherein step a) is initiated near a first critical point of $W(t)$ when $|W(t)| \leq K$, wherein step b) is subsequently initiated near a distinct second critical point of $W(t)$ when $|W(t)| \leq K$, wherein $|W(t)|$ is an absolute value of $W(t)$, wherein K is a pre-determined switching threshold.

8. The method of claim 1 wherein the pre-determined supply level is ground.

9. A method of generating a subscriber line ringing signal, comprising:

a) applying a waveform $L1(t)$ to the tip line; and

b) applying a waveform $L2(t)$ to the ring line, wherein $L2(t) = L1(t + T/2)$, wherein $L1(t)$ and $L2(t)$ have a period of T, wherein at least one of $L1(t)$ and $L2(t)$ varies over the interval $t \in (0, T/2)$.

10. The method of claim 9 wherein step a) further comprises:

i) applying a waveform $W(t)$ to the tip line for a duration T/2, wherein a period of $W(t)$ is T/2; and

ii) grounding the tip line for the duration T/2.

11. The method of claim 10 wherein step i) is initiated when $W(t)$ is near a first critical point, wherein step ii) is initiated when $W(t)$ is near a subsequent second critical point.

12. An apparatus for generating a subscriber line ringing signal, comprising:

a power supply providing a time-varying supply level, $W(t)$;

a linefeed driver; and

a signal processor, wherein the signal processor controls the linefeed driver to couple $W(t)$ to a tip line while maintaining a ring line at a pre-determined supply level for a duration T/2, wherein the signal processor subsequently controls the linefeed driver to couple $W(t)$ to the ring line while maintaining the tip line at the pre-determined supply level for the duration T/2, wherein a resulting ringing signal component of the tip line is $L1(t)$, wherein a resulting ringing signal component of the ring line is $L2(t)$, wherein a differential ringing signal $\Delta L(t) = L1(t) - L2(t)$ has a period T.

13. The apparatus of claim 12 wherein $W(t)$ is periodic with period T/2, wherein $L1(t)$ and $L2(t)$ are periodic with period T.

14. The apparatus of claim 12 wherein $L1(t)$ and $L2(t)$ resemble one of a half-wave rectified sinusoidal and a half-wave rectified trapezoidal waveforms.

15. The apparatus of claim 12 wherein $L2(t) = L1(t + T/2)$.

16. The apparatus of claim 12 wherein $W(t)$ resembles one of a full-wave rectified sinusoid and a full-wave rectified trapezoid.

17. The apparatus of claim 12 wherein the differential ringing signal is one of a sinusoidal, a trapezoidal, a sawtooth, and a triangular waveform.

18. The apparatus of claim 12 wherein the coupling of $W(t)$ to a selected one of the tip and ring lines is initiated when $|W(t)| \le K$, wherein $|W(t)|$ is an absolute value of $W(t)$, wherein K is a pre-determined switching threshold.

19. The apparatus of claim 12 wherein the pre-determined supply level is ground.

20. The apparatus of claim 12 wherein $W(t)$ is coupled to the tip line when $W(t)$ is near a first critical point, wherein $W(t)$ is coupled to the ring line when $W(t)$ is near a subsequent second critical point.

21. The apparatus of claim 12 wherein the linefeed driver operates as switching circuitry during a ringing mode, wherein the linefeed driver operates as a linear amplifier in non-ringing modes.

22. A method of generating a differential ringing signal between a tip and a ring line of a subscriber line, comprising:

a) providing a time-varying supply level, $W(t)$, having a plurality of critical points along a folding line, wherein the critical points are substantially equidistant;

b) coupling $W(t)$ to the tip line while coupling an alternate source to the ring line in response to a first critical point; and

c) coupling $W(t)$ to the ring line while coupling the alternate source to the tip line in response to a second critical point.

23. The method of claim 22 wherein the differential ringing signal is one of a sinusoidal, a trapezoidal, a sawtooth, and a triangular waveform.

24. The method of claim 22 wherein the alternate source is ground.

25. The method of claim 22 wherein the differential ringing signal has a period T, wherein a duration between the first and second critical points is T1, wherein a duration between the second and a next critical point is T2, wherein T1=T2, wherein a period of $W(t)$ is $T/2$.

26. A method of generating a subscriber line ringing signal for a subscriber line having first and second lines, comprising:

a) applying a time-varying supply level $W(t) = |f(t) - C| + C + D$ to the first line while applying an alternate source $V_{ALT}(t) = D$ to the second line when $f(t) - C > 0$, wherein D is a supply level DC offset, wherein C is a folding line about which $f(t)$ is folded; and

b) applying the time-varying supply level to the second line while applying the alternate source to the second line when $f(t) - C \le 0$, wherein a resulting ringing signal component of the first line is L1(t), wherein a resulting ringing signal component of the second line is L2(t), wherein the first and second lines form a differential ringing signal line pair providing the differential ringing signal $\Delta L(t) = L1(t) - L2(t) = f(t)$.

27. The method of claim 26 wherein D=0.

28. The method of claim 26 wherein C=0.

29. The method of claim 26 wherein $W(t) = L1(t) + L2(t)$.

30. The method of claim 26 wherein steps a) and b) are initiated near critical points of $W(t)$ when $W(t) - K = 0$, wherein K is a pre-determined switching threshold, wherein step a) is initiated near a first critical point $W(t_1)$ at $W(t_1 + \varepsilon_1)$, wherein step b) is initiated near a subsequent second critical point $W(t_2)$ at $W(t_2 + \varepsilon_2)$, wherein $|\varepsilon_1|, |\varepsilon_2| << \Delta t = |t_1 - t_2|$.

31. The method of claim 26 wherein $\Delta L(t)$ is periodic with a period T, wherein $\frac{1}{T}\int_0^T \Delta L(t) = \overline{\Delta L(t)} = 0$.

32. An apparatus for generating a subscriber line ringing signal, comprising:

a power supply providing a time-varying supply level $W(t) = |f(t) - C| + C + D$, wherein D is a power supply offset;

a linefeed driver; and

a signal processor, wherein when $W(t) \le K$ the signal processor controls the linefeed driver to toggle between 1) coupling $W(t)$ to a tip line while coupling a ring line to an alternate supply, $V_{ALT}(t)$, and 2) coupling $W(t)$ to the ring line while coupling the tip line to $V_{ALT}(t)$, wherein K is a pre-determined switching threshold.

33. The apparatus of claim 32 wherein $D = 0$.

34. The apparatus of claim 32 wherein $C = 0$.

35. The apparatus of claim 32 wherein K is selected such that the toggling occurs near critical points of $W(t)$, wherein a first toggling occurs at $W(t_1 + \varepsilon_1)$, wherein a second toggling occurs at $W(t_2 + \varepsilon_2)$, wherein $W(t_1)$ and $W(t_2)$ are critical points of $W(t)$, wherein $|\varepsilon_1|, |\varepsilon_2| << \Delta t = |t_1 - t_2|$.